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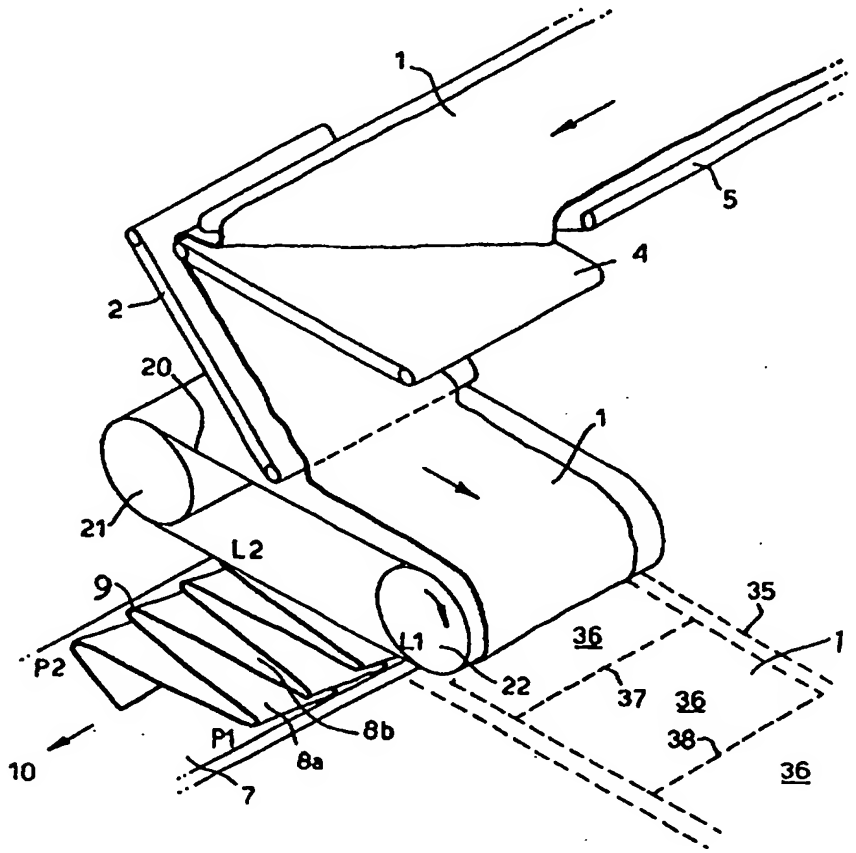
(57) Abstract

A lapped product having laps (8) of a web (1) is made using novel apparatus in which the product is fed to the underside of a permeable carrier (3, 20) and each lap is formed by holding the web by suction to the underside of the carrier as the carrier and the web move above and across a collector (7) and then dropping a length of web onto the collector as a lap (8a, 8b) by releasing the suction. The web (1) can be continuous or it can be formed of discontinuous lengths (36).



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PRODUCTION OF A LAPPED PRODUCT FROM A WEB, AND APPARATUS FOR THIS

This invention relates to process and apparatus for producing a multi-layer product by lapping a web upon itself. The lapping can be in the length direction of the product in which event each lap has the form of a flattened transverse pleat, but the lapping is usually transverse to the length direction of the product with the result that the product is a cross-lapped product.

It is conventional practice, for instance in the manufacture of non-woven fibrous products, to lap a web on itself. This can be lengthwise as flattened pleats, for instance as shown in Figure 2 of EP-B-38887. More usually the web is cross-lapped on itself by a pendulum mechanism, eg as shown in Figure 1 of EP 343,978 or Figure 5 of EP 404,982.

In conventional apparatus, the web is carried on a downwardly inclined feed conveyor which reciprocates about a pivot as a pendulum, and the web is fed off this reciprocating conveyor onto a collector on which it is laid as laps at the rate at which the web approaches the apparatus. Modern production techniques tend to result in very high approach speeds, for instance above 100 metre per minute. Accordingly the feed conveyor has to be capable of laying the web at this speed first in one direction and then in the opposite direction. This imposes severe engineering strains on the mechanism and on the web itself since the reciprocating feed conveyor is repeatedly accelerating and decelerating. Further, the web enters into and exits from the pivoting mechanism at substantially constant speed but is deposited at varying lateral speed. These problems may result in high densities at the edges and low density in the middle of the final layer. In particular, there is a tendency for too much fleece to be accumulated at the relatively slow end of each reciprocation (thus leading to extra thickness at the ends of each lap) and/or for stretching or tearing of the web

which is deposited during the relatively fast central part of each swing, ie in the middle of each lap.

EP-A-329,686 and 528,348 describe modifications of the cross-lapping pendulum mechanism, but they are complicated and in practice do not solve the problems satisfactorily.

It would therefore be desirable to provide a different apparatus that can be simpler, and to facilitate improving the uniformity of deposition of the individual laps of web.

One attempt at solving some of these problems is described in WO87/06631. In this, the fleece is cut into discrete lengths each of which defines a single lap, and these lengths are laid on one another so as to form the lapped product. However it is difficult to perform this process reliably and at high speed.

Another attempt is described in DK 1382/89. In this, web is fed downwardly onto the upper surface of a collecting conveyor as usual, with suction being applied downwardly through the upper surface of the conveyor. Instead of forming the laps by pendulum-like swinging of a downwardly moving feed conveyor, the feed conveyor is fixed and the laps are formed by blowing the web first in one direction and then in the opposite direction as the web emerges from the bottom of the feed conveyor. The described use of reversing transverse air blasts above the suction surface of the collector, optionally accompanied by a downblast when a lap is finally to be deposited onto the collector, can give some degree of lapping. However it is difficult to achieve adequate and uniform results especially when the laps are to be wide, and is not conveniently applicable to all arrangements of laps. For instance it is not satisfactory if the laps are at a significant angle to the transverse direction.

The processes of the invention relate to the production of a lapped product comprising superposed laps having length l from a web and comprise moving the web in a first longitudinal direction with a continuously moving carrier, separating the web from the carrier, depositing

the web as superposed laps on a continuously moving collector and carrying the lapped product on the collector away from the carrier.

In the invention the carrier is permeable and is associated with means for locally applying suction through the carrier and moves in a first longitudinally direction from a first location L1 to a second location L2 spaced from L1 by length l wherein L1 and L2 are above, respectively, first and second positions P1 and P2 on the collector, and each lap is formed by a process comprising holding the web by suction to the underside of the carrier as the carrier and the web move from L1 towards L2 and dropping a length of web onto the collector as a lap extending between positions P1 and P2 by releasing the suction.

Thus, in the invention, we rely upon controlled application and release of suction to dictate the formation and deposition of the laps onto the collector.

There are various ways of achieving this. In some methods the entire lap is accumulated on the carrier by applying suction throughout the entire carrier between locations L1 and L2, and then dropping that lap onto the collector. Thus in these methods, the process comprises holding the web by suction to the underside of the carrier as the web moves from location L1 to L2 and thereby accumulating a length l of web on the carrier between locations L1 and L2 and then releasing the suction between locations L1 and L2 and thereby dropping that length of web onto the collector as a lap extending between positions P1 and P2.

Another way of forming a lap comprises gradually depositing it onto the collector by a method in which suction is applied as the web travels with the carrier from the first location L1 towards the second location L2. Thus, in this method, suction does not have to be applied continuously throughout the entire distance of travel between locations L1 and L2. Instead, the web is held by

suction to the underside of the carrier as the web travels with the carrier from the first location L1 towards the second location L2 and the front edge of the web (i.e. the front edge of the web which is held by suction against the carrier) is released from the carrier by release of suction at half the rate of travel of the carrier, thereby depositing a lap onto the collector. Thus in this method the web is initially held against the carrier at position L1 and as the web and the carrier move towards position L2 the forward travel of the area of suction is half the rate of travel of the carrier so that the web is released from the carrier at half the rate of travel of the carrier, thereby defining a front edge of the web at which the web is folded down from the carrier onto the collector.

Some processes of the invention rely upon both of these techniques for forming alternate laps while other processes rely solely on one of these techniques.

By using the suction techniques of the invention, it is possible to build up the lapped product on the collector by partially overlying one lap on a preceding lap as the collector carries the lapped product away from the carrier in a fast and reliable manner using relatively simple apparatus.

Many of the preferred processes of the invention can be defined as comprising the steps of

(a) continuously moving the carrier in a first longitudinal direction from a first location L1 to a second location L2 spaced from L1 by a length l wherein L1 and L2 are above, respectively, first and second positions P1 and P2 on the collector,

(b) holding the web by suction to the underside of the carrier as the carrier and the web move from L1 to L2 thereby accumulating a length l of web on the carrier between locations L1 and L2,

(c) releasing the suction that holds that length of web and thereby dropping that length of web on to the collector as a lap extending between positions P1 and P2,

and repeating steps (a), (b) and (c).

In one process of the invention the web is continuous as it is being accumulated on the carrier and deposited on the collector as laps. In such a process, it is preferred to interpose some extra steps additional to (a), (b) and (c).

This preferred process comprises continuously feeding the web in a first longitudinal direction in contact at a first location L1 with a permeable carrier which moves substantially continuously substantially in the first longitudinal direction from the first location L1 to a second location L2 wherein the first and second locations are positioned substantially above, respectively, first and second positions P1 and P2 on a collector which is beneath the carrier, and alternately

holding the web by suction against the underside of the carrier as the carrier travels from the first location towards the second location and releasing the front edge of the web from the carrier lengthwise at half the rate of travel of the carrier and thereby depositing a first lap on the collector between the first and second positions while holding a second lap on the carrier, and

then releasing the length of web which extends between the second location and the first location and thereby dropping a second lap between the second and first positions overlying the first lap on the collector, and

continuously carrying the lapped product on the collector away from the carrier.

Such a process can alternately be defined as comprising alternately

(i) performing steps (a) then (b) then (c), and

(ii) then holding the web by suction to the underside of the carrier as the carrier and the web move from L1 to L2 while releasing the front edge of the web from the carrier lengthwise at half the rate of travel of the carrier and thereby depositing another lap (i.e. a first lap) on the collector between the positions P1 and P2 while

accumulating the next length of web (i.e. the web for the second lap) on the carrier between locations L1 and L2.

The invention can also be performed using a web which is in the form of a succession of discrete lengths each length being such as to provide a lap. One type of preferred process of the invention in which the web is discontinuous utilise steps (a), (b) and (c) as the essential steps.

Accordingly the web which moves with the carrier can be in the form of a succession of discrete lengths each having a leading edge and a trailing edge separated by a length l, so that the web which is held by suction to the underside of the carrier in step (b) is in the form of these lengths and each of the lengths in sequence is held by suction against the carrier until, for each individual length, the leading edge of that length is at location L2, and in step (c) the suction that holds that length is released, thereby dropping that discrete length of web as a lap on to the collector. Steps (a), (b) and (c) are repeated sequentially.

Another preferred process in which the web is discontinuous comprises using a web which is in the form of discrete lengths each having a leading edge and a trailing edge separated by a length l, and each discrete length in sequence is held by suction to the underside of the carrier as the discrete length travels from the first location L1 towards the second location L2, and the front edge of the web is released from the carrier at half the rate of travel of the carrier, thereby depositing the discrete length as a lap onto the collector.

Thus, in such processes, the web is initially held by suction at the position L1 and at this time there is generally no necessity to apply suction at positions ahead of L1 (towards L2). Thus, at the start of the process the front of the suction is at or only slightly ahead of L1. The front of the suction is then advanced towards L2 at about half the speed of the carrier until it reaches L2.

The means for applying suction are such that any suction still holding the web to the carrier is released so as to allow the completion of formation of a lap on the collector. If the web is continuous, suction will normally be applied over the entire distance between the suction front and L1. If the web is discontinuous (as described in more detail below), suction may be applied only fro the suction front (corresponding to the front edge of the web) rearwards (towards L1) sufficient to hold the individual length of web against the carrier (generally to near the trailing edge of that length of web).

When the process is conducted using a continuous length of web, the laps will usually be deposited in zig-zag fashion, as is conventional with existing cross lapping processes. When the web is supplied in discrete lengths each of which is to provide a lap, the laps will usually be deposited on the collector substantially parallel to one another.

It will be appreciated that throughout this specification the first and second locations L1 and L2 and the first and second positions P1 and P2 are fixed linear positions that extend transversely across the path of, respectively, the carrier and the collector, and they do not move with the carrier or collector as it travels during the process.

The distance between the notional transverse lines at P1 and P2 (and therefore between the notional lines L1 and L2) defines the length of each lap.

When the laps are deposited transverse to the direction of travel of the collector, it is usually preferred for the notional lines P1 and P2 to extend parallel to the direction of travel of the collector, so that the collected product generally then has a width of l times cosine alpha, where alpha is the angle of the lap to a direction perpendicular to the direction of travel of the collector (see Figure 6). The laps are usually at an angle

different fro 90° to the direction of travel. Each lap generally then has the shape of a rhombus.

When the laps are deposited in the direction of travel of the collector, they are usually rectangular. The width of the collected product is then usually defined by the width of the initial web.

The process can be operated with the collector arranged to carry the lapped product away from the carrier in a longitudinal direction which is substantially the same as the first longitudinal direction. In this instance, the first and second positions are displaced lengthwise along the longitudinal direction of the collector and the laps can be pleats which extend across the width of the collector and of the lapped product.

Preferably, however, the product is a cross-lapped product and the remainder of the description is, for simplicity, written primarily in terms of the production of a cross-lapped product. To make such a product the first and second positions P1 and P2 are on opposite sides of the collector so that the laps extend across the collector, and the collector carries the cross-lapped product away from the carrier in a longitudinal direction substantially transverse to the first longitudinal direction.

In conventional processes the web is unsupported as it comes off the bottom of the pendulum of the cross-lapper and is swung back and forth across the collector, and so the web has to bear both its own weight and the stretching forces created by the cross-lapping mechanism. In the invention the web is held against the carrier during much or the majority of the cross-lapping or other relevant travel and so this greatly minimises the stretching forces to which it may be subjected. Preferably the vertical separation between the carrier and the collector should be as low as possible and is usually less than a metre, often 0.1 to 0.5 metres (preferably about 0.1 to 0.3 metres) and so the amount of unsupported web is always low. The

acceleration and deceleration forces to which the web is subjected can be extremely low, even with high web speeds.

The carrier is preferably an endless permeable carrier having a lower path of travel which includes the first and second locations and which is above the part of the collector which extends between the first and second positions on the collector.

The carrier can be a drum. However it is desirable for it to have a large radius of curvature, for instance, a radius at least twice, and preferably at least four times, the distance between the first and second locations. Otherwise the radius of curvature along the lower path of travel may be such as to result in the fleece being unsupported for an undesirable distance. Preferably the endless carrier has a substantially flat lower path of travel between the first and second locations. Accordingly the preferred carrier comprises an endless belt which travels around end rollers and wherein the first and second locations are both on the lower path of travel of the belt. Conveniently the length of this lower path is 1 to 2 times, usually 1.1 to 1.5 times, the length between the first and second locations.

It is necessary that the web should be held substantially in contact with the carrier substantially at the first location L1 throughout the process. Thus it is normally held by suction in contact with the carrier at the first location L1 (or at a position immediately preceding it) throughout the process. In those embodiments where it is released at location L1 to allow the entire lap to drop down onto the carrier, the web at the position immediately preceding L1 is held by suction ready for the next cycle of the process.

The web can be brought into contact with the carrier initially immediately before or at the first location L1, and for instance guided onto the carrier and held in contact with it by a roller or other supporting member. Preferably, however, the web is continuously fed into

contact with the carrier at a feed location which precedes the first location, and the web is then held against the carrier, generally by suction, as the web travels with the carrier from the feed location to the first location. When, as is preferred, the carrier is an endless carrier, the feed location may be at a higher position whereby the web travels downwardly with the carrier and in contact with the carrier from the feed location to the first location.

The web is preferably fed onto the carrier at an angle less than the perpendicular so as to minimise the change in direction of movement of the web as it starts to travel with the carrier. For instance the angle is often less than 70°, e.g., 30° to 60°.

When the web which moves with the carrier and is held against the carrier is a continuous web, the lengths of web which are to form the first and second laps may be collected simultaneously by the carrier, with the first lap being laid gradually onto the collector (and thereby being carried away by the collector) and the second lap then being dropped (optionally with blowing) down onto the first lap.

In order that the length of web which is to form a first lap is not distorted excessively as it is laid down onto the collector, the direction of travel as it is laid onto the collector is generally substantially unchanged from its direction of travel on the carrier, ie the first longitudinal direction. If there is any deviation in its direction of travel as it is laid down, the deviation should preferably be small, eg below 10° and usually below 5°.

Application of suction up through the carrier will hold the web against the carrier and release of the web from the carrier can then be achieved by terminating the suction locally, when required. However the weight of the web may be insufficient to achieve sufficiently precise release for optimum performance and in these instances it is desirable for the carrier to include means for locally

applying air pressure downwardly through the carrier for releasing the web from the carrier. Thus the web can be held on the carrier by sucking air inwardly through the web and the permeable carrier, and release can be promoted by reversing the air flow and forcing it downwardly through the carrier.

Since the overall process generally involves either or both of (a) holding the web against the carrier as the carrier travels from the first location towards the second location and releasing the front edge of the web from the carrier lengthwise at half the rate of travel of the carrier and (b) releasing a length of web which has accumulated on the carrier and which extends from the second location to the first location, it is preferred for there to be a lengthwise plurality of means for applying suction and optionally air pressure through the carrier.

Preferably the carrier travels over or with a plurality of transverse suction boxes or other suction means as the carrier travels from the first location to the second location whereby suction can be applied alternately through the entire length of travel of web from the first location to the second location, followed by termination of suction throughout this length and optionally the application of downward pressure for releasing the web between the second and first locations from the carrier, and then a gradually increasing length of travel from the first location to the second location. Also there can be suction means for applying suction through the carrier as the carrier travels from the feed location to the first location, when the feed location is at a point before the first location.

The carrier is associated with means for locally applying suction through the carrier, i.e., through part only of the surface of the carrier. The suction means can include ducts which travel with the carrier, together with means for applying suction to each duct individually as required according to the position of the carrier.

Preferably, however, the carrier is a permeable belt which has a substantially flat lower path of travel which extends between the first and second locations and which passes under a plurality of adjacent transverse suction boxes through each of which suction can be applied upwardly substantially independent of the others. Preferably air pressure can also be applied downwardly through each of the boxes independent of the others. Thus preferably each of the boxes is connected independently to a manifold by which that box can independently be put under suction or elevated air pressure. We use the term suction box to denote any open duct or other means which extends substantially across the carrier and by which a relatively narrow band of suction can be applied through the carrier to the web. The amount of suction can be quite low eg about minus 10 mm water column.

If it is desired that the lapped product should merely consist of two layers of web at any one point each lap should be laid at an angle of about 45° to the transverse direction of the collector. This is the appropriate angle when the lapped product is to have the same width as the starting web. If the lapped product is to be of a different width, a different angle may be appropriate. For instance, if the lapped product is only about half or two-thirds the width of the web the angle may be up to about 75°.

If, as is usual, the lapped product has a greater number of laps, for instance at least 4 and often at least 7 or 10 or more then the angle of each lap to the transverse direction of the collector will be less. For instance the angle to the transverse direction for 4 laps will typically be in the range 10-25°, for 10 laps 4 to 10° and for 15 laps 3-7°, each depending on the width of the lapped product relative to the width of the initial web. When they have the same width, the angles are, respectively, about 15°, 6° and 4°.

When making a cross-lapped product, it is preferred that the suction means should, at all times, extend substantially along the length direction of the collector in order that a line joining the first and second locations and a line joining the first and second positions should each extend substantially along the length direction. When the laps are to extend lengthwise, the lines joining the first and second locations and joining the first and second positions should extend substantially transverse to the length direction. In order to avoid the risk of edge distortions of the web, it is preferred that the carrier should travel in substantially the same direction as the lap which is to be dropped down onto the collector. For instance if the lap is to be deposited at an angle of 45° to the transverse direction of the collector, then preferably the carrier travels at that angle so as to drop the lap on the collector at the desired orientation.

When the web is continuous and the alternate lap is deposited gradually onto the collector as the collector travels beneath the carrier, this alternate lap will acquire the desired opposite angular orientation as it is laid onto the collector.

If the number of laps is high, so that the angular displacement of each is small, then it can be adequate for the carrier to move at right angles to the direction of travel of the collector. However, it is generally preferred for the apparatus to be constructed so that the length direction of the suction boxes can be different from the direction which is perpendicular to the direction of the travel of the carrier. Further it is generally preferred that the carrier and the boxes should be orientable independably of each other. Preferably the suction boxes are fixed in the longitudinal direction of the collector and the carrier is pivotable relative to the boxes around a suitable vertical axis, to allow adjustment according to the number of laps. The pivot angle may be 0 to about 75° or more, usually 0 to about 45°.

The width of the collected cross-lapped product can be the same as or different from the width of the web and is controlled by appropriate selection of the locations L1 and L2 and positions P1 and P2. L1 and P1 are defined by the point at which suction is continuously applied, and L2 and P2 are defined by the point at which suction is never applied (and in practice often where air is always forced outwardly from the carrier). Accordingly the width of the cross-lapped product can easily be adjusted as desired by varying the supply of suction or air to the outermost suction boxes.

If desired two (or more) webs may be supplied onto a single carrier so that the web which is lapped is itself a laminate. If desired the web (or webs) fed onto the carrier may be cross-lapped, for instance being a product made by the process of the invention. Thus two or more of the cross-lapping systems of the invention may be arranged in series. Accordingly a double cross-lapped product can be made. These modifications lead to products which have very high uniformity and which can be made from very fast moving webs.

When the web which moves with the carrier is in the form of discrete lengths then, as mentioned above, the laps may be deposited substantially parallel with each other on the collector, as the collector carries the lapped product away from the carrier. This can be as a result of each length in sequence being held by suction on the carrier until it is located between positions L1 and L2, with the result that each length can be dropped in sequence down on to the collector between positions P1 and P2. Alternatively it can be as a result of each length in sequence being held by suction to the underside of the carrier as the web and the carrier travels from position L1 towards L2, with the front edge of the web being released from the carrier at half the rate of travel of the carrier.

In such processes using discrete lengths of web, the web may be cut transversely while it is on the carrier, and thus the web may be fed as a continuous web on to the carrier and then cut transversely either at the first location L1 or at some location on the carrier prior to the first location. The cuts should preferably be inclined at the angle alpha in relation to the web cross direction. Alternatively the web can be in the form of a succession of discrete lengths before this discontinuous web starts moving with the carrier. Thus a continuous web may be cut transversely into the desired discrete lengths and the resultant succession of discrete lengths may be fed to the carrier and then move with the carrier.

Although the discrete lengths can be of variable length, this is normally undesirable and so it is preferred for all the lengths to have substantially the same dimensions.

The laps will usually all lay on the collector at substantially the same angle and parallel to one another. The angle that each lap makes to the transverse direction of the collector can be selected in accordance with the number of laps that are required, and the relationship between the number of laps and the angle of each to the transverse direction of the collector will normally be similar to or the same as the relationship discussed above in connection with the continuous zig-zag product.

The permeable carrier and all other details of the process and the apparatus can be the same for the process using discontinuous lengths as for the process using a continuous web.

The invention is of particular value when the web is supplied at high speeds, for instance at 100 metres per minute or more, typically 150 to 300 or 400 metres per minute.

The web can be a paper sheet, plastic film or other sheet having structural integrity, but preferably it is an air laid non-woven web. The web can be made of organic

fibres such as cotton, cellulose, polyamide or nylon and thus can be, for instance, a web of the type used for the manufacture of clothing, inner linings or other organic textiles.

Preferably, however, the web is a web of mineral fibres, preferably being an air laid web of mineral fibres.

The invention is of particular value when the web is a material made by fiberising a vitreous melt by use of at least one centrifugal fiberising rotor and thereby forming a cloud of fibres, carrying the cloud of fibres by an airstream from adjacent the rotor or rotors to a permeable collector, and collecting the fibres as a web on the collector.

The fibres may be formed using a spinning cup which rotates about a substantially vertical axis. Melt is fed into the cup and thrown out through perforations in the wall of the cup as fibres. The fibres may be attenuated by an annular air stream (often hot) and are collected downwardly onto a collector that moves beneath the cup.

Preferably, however, the fibres are formed using one or more fiberising rotors which rotate about a substantially horizontal axis and the cloud of fibres is carried substantially horizontally onto a permeable collector by which the fibres are carried as a web away from the fiberising apparatus. For instance the fibres may be formed using a cascade spinner comprising a first rotor onto which melt is poured and off which it is thrown centrifugally and at least one subsequent rotor onto which the melt is thrown from the preceding rotor and off which fibres are thrown, and an airstream emerges from around the individual rotors and/or around the cascade spinner and carries the resultant fibres to a moving permeable collector on which they are collected as a web. The collector is usually upwardly inclined.

The collected web of fibres can then be carried to the apparatus for forming the lapped product using conventional conveyers.

Accordingly, all processes of the invention preferably comprise a preliminary step of fiberising a mineral melt into a stream of air, carrying the fibres in a stream of air into a collecting chamber and collecting the fibres on a permeable conveyor in the chamber and thereby forming the web which is subsequently lapped.

The application of suction through the lapping carrier necessarily involves sucking air which is liable to be contaminated with fibre, uncured binder and other suspended materials. Normally this air would have to be vented to the atmosphere after cleaning, but according to a further aspect of the invention the air utilised for applying suction through the permeable carrier is recycled as part of the stream of air into which the melt is fiberised. Accordingly it is not necessary to purify and discharge the suction air and, instead, it can be reused as part of the fiberising air in conventional manner. Thus the invention has the advantages of allowing for much simpler and smaller apparatus and less risk of damage to the web without the associated disadvantage of increasing the gaseous effluent from the overall process.

When forming a web of mineral fibres by collecting the fibres on a permeable conveyor in a collecting chamber, in conventional manner, the conveyor is often an upwardly inclined conveyor, especially when the fibres are formed by fiberisation on a cascade spinner having a plurality of substantially cylindrical rotors which rotate about a substantially horizontal axis. The web which is formed in the collecting chamber on the conveyor is then discharged from the top of the collecting chamber. In conventional processes it is carried away from the conveyor and is subjected to conventional cross lapping processes using bulky apparatus at some significant distance from the chamber, e.g., several metres or tens of metres away from the chamber. Because of the compactness of the apparatus used for the lapping process of the invention, it is preferred that the web which is formed on the conveyor and

discharged from the top of the chamber is fed substantially directly to the underside of the lapping carrier used in the invention. It then moves with the carrier and is held to that carrier by suction as the carrier and the web move from location L1 to L2, so that the web can be converted to a lapped product by the process of the invention substantially directly upon emerging from the chamber, for instance without any significant intermediate travel, e.g., of more than 5 or 10 metres. The conversion to a lapped product is generally conducted without any intermediate mechanical handling process other than, possibly, a turning process.

Instead of lapping the web substantially directly after it emerges from the top of a chamber the end of which is defined by the upwardly inclined conveyor, it is also possible for the web which is formed on the conveyor to be discharged from the top of the chamber and carried downwardly to a position which is beneath the upwardly inclined conveyor but is adjacent to the chamber, and again the web can (at this position) move with the carrier and be held to the underside of the carrier by suction as the carrier and the web move from location L1 to L2, whereupon the lapping process of the invention can then be conducted at a position underneath the upwardly inclined conveyor. This position again will generally be within 5 to 10 metres of the chamber and again there is preferably no substantial mechanical operation applied to the web between emerging from the chamber and being subjected to the lapping process, other than travel down and underneath the upwardly inclined conveyor. Again this has the advantage of allowing cross lapping to occur at a convenient location using small apparatus close to the collecting chamber.

The invention includes both the novel lapping and turning processes described above and the novel apparatus described above by which the processes can be conducted.

Novel apparatus suitable for use in the process comprises a continuously movable carrier for supplying a

web, means for separating the web from the carrier, means for depositing the web as superposed laps on a continuously movable collector and means for carrying the lapped product on the collector away from the carrier, and the apparatus is characterised in that

the carrier is permeable and is associated with means for locally applying suction through the carrier, and the apparatus comprises

means for moving the carrier in a first longitudinal direction from a first location L1 to a second location L2 spaced from L1 by a length l wherein L1 and L2 are above, respectively, first and second positions P1 and P2 on the collector, and

means for holding the web by suction to the underside of the carrier as the carrier and the web move from L1 towards L2 and for dropping a length of web onto the collector as a lap extending between positions P1 and P2 by releasing the suction.

In some embodiments of the invention, the means for holding the web by suction to the underside of the carrier are means for holding the web to the underside of the carrier as the carrier and the web move from L1 to L2 thereby accumulating a length l of web on the carrier between locations L1 and L2, and there are means for releasing the suction that holds the length of web and thereby dropping that length on to the collector as a lap extending between positions P1 and P2.

In other apparatus according to the invention the means for holding the web by suction to the underside of the carrier comprise means for holding the web by suction to the carrier as the web travels with the carrier from the first location L1 towards the second location L2 and for releasing the front edge of the web from the carrier at half the rate of travel of the carrier and thereby depositing a lap onto the collector.

Preferred novel apparatus for making a lapped product from a continuous web comprises a collector on which the

lapped product can be formed and carried away continuously, and a permeable carrier which is an endless carrier having a lower path of travel above the collector extending between first and second locations on the carrier and means for alternately

holding the web against the carrier as the carrier travels from the first location to the second location and releasing the leading edge of the web from the carrier lengthwise at half the rate of travel of the carrier and thereby depositing a first lap on the collector between the first and second positions while holding a second lap on the carrier, and

then releasing the length of web which extends between the second location and the first location and thereby depositing a second lap between the second and first positions overlying the first lap on the collector.

The invention is illustrated in the accompanying drawings in which:

Figure 1 is a perspective view of one apparatus according to the invention which is in use.

Figure 2 is a perspective view of another arrangement of apparatus according to the invention which is in use.

Figures 3a, 3b, 3c and 3d are an enlarged diagrammatic cross-section of an apparatus somewhat similar to that shown in Figure 1 and showing the different stages of lap formation.

Figure 4 is a cross-section through part of a different form of apparatus.

Figure 5 is a cross-section on the line 5-5 in Figure 4.

Figure 6 is a plan view showing an arrangement of carrier and collector, in use, of the general type shown in Figures 4 and 5.

Figure 7 is a perspective view of an apparatus which includes the collector carrier arrangement shown in Figure 6.

Figures 8 and 9 are diagrammatic representations of the combination of the lapping apparatus with a spinning chamber.

Figure 10 is three diagrammatic representations of another apparatus for lapping discontinuous web onto a collector, each being shown at a different stage in a lapping cycle.

Referring to Figure 1, a web 1 is fed by a feed conveyer 2 onto the feed location FL of a cylindrical carrier 3. The conveyor 2 makes a small angle, e.g., 10-45°, with the carrier at FL. The feed conveyer 2 is shown in Figure 1 as a component of a series of conveyers 2, 4, 5 by which the web is turned through 90° as it approaches the carrier 3.

The carrier 3 is a perforated drum provided with means 6 for applying suction to the centre of the drum, as a result of which the web 1 is held on the surface of the drum as the drum rotates. Accordingly the web 1 is held against the carrier 3 as the web travels with the carrier from the feed location FL to a first location L1 on the carrier 3 situated above a first positions P1 on a collector conveyor 7.

As explained in more detail below with reference to Figure 3, the web is alternately carried with the drum 3 to second location L2. At this stage the web extending between L2 and L1 is dropped onto the collector 7 as a transverse second lap 8b. The next adjacent transverse lap (a first lap) 8a is laid on the second by web subsequently being carried from the first location to the second location and released gradually lengthwise (between L1 and L2) onto the collector 7 and simultaneously the length of web which is to form the next second lap is accumulated on and held on the drum.

The conveyer 7 carries the cross-lapped product 9 consisting of the transverse laps 8 longitudinally away from the carrier in the general longitudinal direction 10. It will be seen that the longitudinal direction 10 of the

collector 7 is substantially transverse to the direction of feed by the initial feed conveyer 2.

Figure 2 shows an alternative embodiment. One variation is that the feed conveyer 2 discharges against the drum at a feed location FL which is somewhat closer to the conveyer and from which the web is carried downwardly to the first location L1. A more significant difference between the apparatus of Figures 1 and 2 is that the collector 7 carries the lapped product away from the carrier 3 with a longitudinal direction which is substantially the same as the longitudinal feed direction of the conveyer 2. The laps 8 therefore extend lengthwise, instead of being cross-lapped, and can be regarded as transversely arranged flattened pleats.

Figures 3a to 3d illustrate a preferred way of forming the cross-laps shown in Figure 1 using apparatus similar to Figure 1 except that the feed conveyer 2 discharges the web 1 onto the carrier at a position at the side of the carrier drum 3.

The carrier 3 has a permeable screen 11 defining its cylindrical surface and is fitted internally with three sets of internal suction boxes 12, 13, 14, 15 and 16 each provided with means 17 for engagement with a suitable manifold (not shown) within the drum by which suction (indicated by the sign -) or excess pressure (indicated by the sign +) can be applied through the suction box.

The stage in the cycle shown in Figure 3a is the stage in which pressure has just been applied to the lower most suction box 12 so as to blast a second lap 8b downwardly onto the upper surface of the collector 7. The length of this lap extends between positions L1 and L2 on the carrier 3 and between positions P1 and P2 (directly underneath positions L1 and L2) on the collector 7.

In the next stage of the cycle a length of web is carried by suction box 13 from position L1 towards position L2, until suction box 14 reaches position L1 whereupon pressure is applied through box 13 to release a short

length 8b which extends from L1 to the fold or front edge 33 of the web, which leads back to short length which extends to P1. This is the position shown in Figure 3b.

The process continues with the web gradually being released lengthwise from the carrier as the web travels with the carrier from L1 to L2. The rate of travel lengthwise of the position on the carrier at which the front edge 33 is released is about half the rate of travel of the carrier, in order that the lengths 8a and 8b grow at approximately the same rate. In Figure 3c the position is shown where the length of the first lap 8a which has laid down onto the previous second lap 8b has increased in length and a corresponding length 8b has accumulated on the carrier as a result of suction still being applied through boxes 15 and 16 but not through boxes 13 or 14.

In subsequent stages pressure is applied through boxes 15 and 16 as the length of the first lap 8a laid onto second lap 8b increases and finally the full length of that first lap 8a is laid onto the previous second lap 8b by the next box 12. When the box 12 extends between positions L1 and L2 (as shown in Figure 3d) the vacuum is switched off and if necessary excess air pressure is blown through box 12 so as to drop the next second lap 8b onto first lap 8a. The cycle is then at the position shown in Figure 3a.

Throughout this time, the conveyer 7 has been travelling substantially transverse to the direction of the laps that are being deposited so as to form the cross-lapped product 9 shown in Figure 1.

It is desirable, for good control of the process, that the radius of curvature of the drum should be as large as possible and preferably this is achieved by using, as carrier, an endless carrier as shown in Figure 4. This endless carrier comprises an endless perforated band 20 that passes around drums 21 and 22. The lower path of travel 23 is flat and extends at least between positions L1 and L2 above positions P1 and P2 on the collector 7. Separation between the collector and the carrier is

typically in the range 0.1 to 1, often around 0.2 to 0.5, metres in this embodiment (and all embodiments) of the invention.

There is a series of adjacent transverse suction boxes 24 by which suction can be applied upwardly through the band 20 as it passes along the lower path of travel and, alternatively, by which high pressure air can be forced downwardly through the band. There is a suitable manifold arrangement 25 for alternately and independently supplying suction or elevated pressure. This comprises a high pressure chamber 26, a low pressure chamber 27 and a control mechanism 28 by which a valve 29 can be operated to expose the box 24 either to the high pressure chamber or to the low pressure chamber.

The edge of each lap is shown diagrammatically as 30 in Figure 6. It makes an angle α to the transverse direction which will vary according to the extent of cross-lapping. If the final product is to consist merely of two layers of web then the angle α will be 45° (under idealised conditions) but usually the number of laps is greater, typically 4 to 10, in which event the size of the angle α will be, for instance, from 2 to 15°.

It is desirable that the positions L1 and L2 and P1 and P2 should be as close as reasonably possible to being parallel with the direction of travel 10 of the cross-lapped product on the collector 7. If the angle α is small then it can be adequate for the carrier 3 or 20 to be arranged with its direction of travel substantially perpendicular to the direction 10. However there can be some distortion at the edges even with small angles and so it is generally preferred that the carrier 3 or 20 is arranged at an angle to the collector 7. This angle should be substantially the same as the angle that will be made by the second lap 8b as that is dropped down onto the collector (for instance at the stage shown in Figure 3a).

Thus, in Figure 6, the carrier 20 is shown as being arranged at an angle α to the direction which is

perpendicular to the longitudinal direction 10. However the suction boxes are arranged substantially in the longitudinal direction 10 and thus are at an angle α to the direction which is perpendicular to the direction of travel of the carrier 3 or 20.

Since it is generally convenient to be able to make, using a single apparatus, products having both a high degree and a low degree of cross-lapping, it is preferred that the carrier 20 should be capable of being pivoted about its central point 31, without movement of the suction boxes 24, between angles of α which are small (when there are a large number of cross-laps), or as much as 75° (when there are only two cross-laps). Thus the carrier may be pivotable between 0 and 75° to the direction of the carrier or, in some instances, over a smaller range, typically above 5° and/or up to 30°. Conveniently the suction boxes 24 extend beyond the width of the carrier 20 and, at any particular time, the parts of the suction boxes that are not exposed to the lower path of travel 23 are blocked off as shown by the cross-hatching at 32.

The cross-lapped product can then be subjected to calendering or other conventional post-treatments. The described apparatus shown in the drawings as being applied to the lapping of a continuous web. When the apparatus is to be used for cross lapping discrete lengths, it can be modified as shown by the dashed lines in Figure 7. Thus the feed consisting of elements 2, 4 and 5 can be omitted and replaced by a feed conveyor 35 which feeds discrete lengths 36 of the web to the underside of the permeable carrier 20. Each length 36 has a leading edge 37 and a trailing edge 38, the edges 37 and 38 being separated by a length l. Each of these discrete lengths will be held to the carrier as the leading edge 37 moves from position L1 to L2 whereupon the vacuum system is controlled so as to release the vacuum holding that length and start applying vacuum to hold the leading edge 37 of the next length 36 which is passing position L1. Each of the lengths 36 will

then be dropped as a lap 8 on to the collector 7. Whereas in Figure 7 the laps are shown as having a zig-zag configuration (because they are formed from a continuous web) in the modification using discrete lengths all the laps will be parallel to one another having the configuration of laps 8b in Figure 7, i.e., substantially parallel to the direction of travel of the pieces 36 as they are carried on the carrier above the collector 7.

All the illustrated embodiments of the invention may be utilised in combination with conventional web forming and handling machinery. Thus they may lead to calender rolls or other conventional apparatus for treating the lapped web and they may lead from appropriate apparatus for forming the web by air laying.

In Figure 8, the web 1 is formed of mineral fibres which are produced in known manner using a centrifugal cascade spinner 39. This discharges towards a permeable collector 40 which defines one end of a collection chamber 41, which is provided with a pit for coarse or waste products 42, in conventional manner.

The fiberisation of mineral melt using the cascade spinner 39 involves centrifugally forming the fibres into an air stream part of which may flow through apertures within the spinning apparatus 39 and part of which may flow around the spinning apparatus through the passage 43. This is all conventional for the production of mineral wool fibres.

The web 1 which is collected on the collector 40 is usually taken off from the top 44 from the chamber on the upper surface of a conveyor which leads it to conventional bulky cross lapping or other apparatus. Because of the compact nature of the lapping apparatus of the invention, in the invention the web 1 which emerges from the top 44 of the chamber can be fed directly to the underside of permeable carrier 20 and then cross lapped, for instance as shown in Figure 7. Thus it is possible to form a cross

lapped product immediately adjacent to the collecting chamber.

In the apparatus shown in Figure 8, the collector 20 is shown as a separate element extending from a fixed roof 45 of the chamber. In another variation, the permeable carrier 20 can define most or all of the upper roof of the chamber, with the localised area for applying suction, and thus for causing the cross lapping, being outside the chamber to cause cross-lapping at the position 46.

In the apparatus shown in Figure 9 the collector 40 is a continuous belt which travels around guides 47, 48 and 49 (as in Figure 8) and the web is carried on the collector 40 as it travels down and underneath the collecting surface in the chamber. The collector 40 travels over suction boxes 24, which may be operated as shown in Figure 7 to cause cross lapping at the position 46. Thus, in this embodiment, the cross lapping is conducted underneath the collector 40 of the collection chamber.

In the apparatus shown in each part of Figure 10, a succession of lengths 51, 52, 53, 54 and 55 of a continuous web travel with the carrier while held to the underside of the carrier by suction as the carrier and the pieces travel first to location L1 and then as the carrier and the pieces travel towards location L2. In the upper part of the drawing, the position is shown after piece 51 has been deposited as a lap on the collector and as piece 52 is midway through deposition on the collector. As will be seen, the leading half of the piece has been deposited onto the preceding piece 51 and is folded back at the front edge 33 of the web, while the trailing half of the piece is still held by suction to the carrier 20.

In the middle part of the drawing, the front three quarters of the piece 52 has been deposited onto the piece 51 while the trailing quarter is still held to the carrier, and the first quarter of the next piece 53 has been deposited onto the preceding piece 52 on the collector 7,

while the remaining three quarters of the piece 53 is still held by suction to the underside of the carrier.

In the lower part of the drawing, the whole of piece 52 is laying as a lap on the collector 7, above piece 51, while the leading half of the piece 53 is also laid onto the collector 7 but the trailing half is still held by suction to the underside of the carrier.

In order to ensure that the leading edge (for instance edge 54a) of each piece in turn drops down onto the collector 7 with the desired configuration, as shown in the drawings, it can be desirable to provide means for applying suction down through the collector adjacent its edge 60 so as to pull the front edge, such as 54a, down onto the edge of the collector and/or to blow air down through the carrier at position L1, so as to blow the leading edge (eg 54a) down onto the collector.

The following are examples of a process in which a mineral wool web is formed by a cascade spinner in a collection chamber in conventional manner and is carried by conveyer 2 to a feed location FL in apparatus as shown in Figure 7.

Example 1

A continuous web 1.8m wide is fed at 300m/min into the apparatus shown in Figure 7 wherein the carrier is arranged at 4.3° to the perpendicular to the longitudinal direction of the collector. The process is conducted at 75 cycles/min to provide a cross-lapped product having 12 layers of web and a width of 2m at 22.5m/min.

Example 2

A web 2m wide is fed at 120m/min into the apparatus shown in Figure 7 wherein the carrier is arranged at 45° to the longitudinal direction of the collector. The process is conducted at 21 cycles/min to provide a cross-lapped product having 2 layers of web and a width of 2m at 60m/min.

CLAIMS

1. A process for producing a lapped product (9) comprising superposed laps (8) having length l from a web (1) by moving the web (1) in a first direction with a continuously moving carrier (3, 20), separating the web from the carrier, depositing the web as superposed laps on a continuously moving collector (7) and carrying the lapped product (9) on the collector (7) away from the carrier (3, 20), characterised in that

the carrier (3, 20) is permeable and is associated with means (13-17, 24, 25) for locally applying suction through the carrier and moves in a first longitudinal direction from a first location L1 to a second location L2 spaced from L1 by a length l wherein L1 and L2 are above, respectively, first and second positions P1 and P2 on the collector (7), and each lap is formed by a process comprising holding the web (1) by suction to the underside of the carrier (3, 20) as the carrier and the web move from L1 towards L2 and dropping a length of web on to the collector as a lap extending between positions P1 and P2 by releasing the suction.

2. A process according to claim 1 in which the first and second positions are on opposite sides of a longitudinally moving collector whereby the laps extend across the collector to form a cross-lapped product, and the collector carries the cross-lapped product away from the carrier in a direction substantially transverse to the first longitudinal direction.

3. A process according to claim 1 or claim 2 in which the carrier is an endless carrier having a lower path of travel which includes the first and second locations above the collector.

4. A process according to any preceding claim in which the carrier is a permeable belt having a substantially flat lower path of travel which extends between the first and second locations and which passes under a plurality of adjacent transverse suction means through which suction can

be applied upwardly substantially independently of each other.

5. A process according to claim 4 a length of web is accumulated on the carrier between positions L1 and L2 and this length is the dropped, as a lap, down onto the collector by releasing the suction, and in which the suction boxes are arranged substantially parallel to the direction of travel of the collector and the carrier is arranged at an angle such that the carrier has a direction of travel substantially parallel to the desired direction of the length as it is dropped down onto the collector.

6. A process according to claim 5 in which the carrier is pivotable about a vertical axis at angles within the range 0-75° to the direction perpendicular to the direction of travel of the collector.

7. A process according to any preceding claim in which release of the web from the carrier is promoted by the local application of downward air pressure through the carrier.

8. A process according to any preceding claim in which the web is fed to the carrier at a speed of at least 100 metres per minute, preferably 150 to 400 metres per minute.

9. A process according to any preceding claim in which the web is an air-laid web of fibres.

10. A process according to any preceding claim in which the web is an air-laid web of mineral wool fibres made by fiberising a melt and collecting the fibres as a web.

11. A process according to any preceding claim which comprises holding the web by suction to the underside of the carrier as the web moves from location L1 to location L2 and thereby accumulating a length l of web on the carrier between locations L1 and L2 and then releasing the suction between locations L1 and L2 and thereby dropping that length of web onto the collector as a lap extending between positions P1 and P2.

12. A process according to any preceding claim comprising holding the web by suction to the underside of the carrier

as the web travels with the carrier from the first location L1 towards the second location L2 and releasing the front edge of the web from the carrier at substantially half the rate of travel of the carrier and thereby depositing a lap onto the collector between positions P1 and P2.

13. A process according to claim 12 in which the web which is held by suction to the underside of the carrier is in the form of discontinuous lengths each having a length l and the process comprises holding the lengths by suction to the underside of the carrier as the lengths travel with the carrier from the first location L1 towards the second location L2 and releasing the front edge of each length in sequence from the carrier at substantially half the rate of travel of the carrier and thereby depositing each length as a lap onto the collector.

14. A process according to claim 11 in which the web which moves with the carrier is in the form of a succession of discrete lengths each having a leading edge and a trailing edge and a length l, and each of the lengths in sequence is held by suction against the carrier until the leading edge is at location L2 and then the suction that holds that length is released thereby dropping a series of substantially parallel overlapping laps on the collector.

15. A process according to any of claims 1 to 10 and which comprises alternately

(i) the steps comprising

(a) moving the carrier in a first longitudinally direction from a first location L1 to a second location L2 spaced from L1 by a length l wherein L1 and L2 are above, respectively, first and second positions P1 and P2 on the collector,

(b) holding the web by suction to the underside of the carrier as the carrier and the web move from L1 to L2 thereby accumulating a length l of the web on the carrier between locations L1 and L2, and

(c) releasing the suction that holds the length of web and thereby dropping that length of web onto the

collector at a lap extending between positions P1 and P2 and

(ii) then holding the web by suction to the underside of the carrier as the carrier and the web move from L1 to L2 while releasing the front edge of the web from the carrier lengthwise at half the rate of travel of the carrier and thereby depositing another lap on the collector between the positions P1 and P2 while accumulating the next length of web on the carrier between locations L1 and L2.

16. A process according to claim 15 in which the carrier travels from the first location to the second location under or with a plurality of transverse suction means whereby suction is applied to the web alternately

through the entire length of travel from the first location to the second location followed by termination of suction throughout this length and optionally the application of downward pressure for releasing the web between the second and first locations from the carrier, and

then through a gradually increasing length of the travel from the first location to the second location, and

optionally whereby suction is also applied as the carrier travels from a feed location to the first location.

17. A process according to claim 1 for producing a lapped product from a web 1 comprising

continuously feeding the web in a first longitudinal direction in contact at a first location L1 with a permeable carrier which is associated with means for locally applying suction through the carrier and which moves continuously substantially in the first longitudinal direction from the first location L1 to a second location L2 wherein the first and second locations are positioned above, respectively, first and second positions P1 and P2 on a collector which is beneath the carrier and alternately

holding the web 1 by suction against the carrier as the web 1 travels with the carrier from the first location L1 to the second location L2 and releasing the front edge

of the web from the carrier lengthwise at half the rate of travel of the carrier and thereby depositing a first lap on the collector between the first and second positions P1 and P2 while holding a second lap on the carrier, and

then releasing the length of web which is held on the carrier between the second location L2 and the first location L1 and thereby depositing a second lap between the second and first positions P2 and P1 overlying the first lap on the collector, and

continuously carrying the lapped product on the collector away from the carrier.

18. A process according to any preceding claim comprising the preliminary step of fiberising a mineral melt into a stream of air, carrying the fibres in a stream of air into a collecting chamber and collecting the fibres on a permeable conveyor in the chamber and thereby forming the web.

19. A process according to claim 18 in which the air utilised for applying suction through the permeable carrier is recycled as part of the stream of air into which the melt is fiberised.

20. A process according to claim 18 or claim 19 in which the conveyor is an upwardly inclined conveyor which defines one end of the collecting chamber and the web which is formed on the conveyor is discharged from the top of the conveyor substantially directly to the underside of the carrier and moves with the carrier and is held to that carrier by suction as the carrier and the web move from location L1 to location L2.

21. A process according to claim 18 or claim 19 in which the conveyor is an upwardly inclined conveyor which defines one end of the collecting chamber, the web which is formed on the conveyor is discharged from the top of the chamber and is carried downwardly to a position which is beneath the upwardly inclined conveyor but adjacent to the chamber and at which the web moves with the carrier and is held to

the underside of the carrier by suction as the carrier and the web move from position L1 to L2.

22. Apparatus suitable for use in the process of claim 1 comprising a continuously movable carrier (3, 20) for a web (1), means for separating the web from the carrier, means for depositing the web as superposed laps 8 on a continuously movable collector (7) and means for carrying the lapped product on the collector (7) away from the carrier (3, 20), characterised in that

the carrier (3, 20) is permeable and is associated with means (13-17, 24, 25) for locally applying suction through the carrier, and the apparatus comprises means for moving the carrier in a first longitudinal direction from a first location L1 to a second location L2 spaced from L1 by a length l wherein L1 and L2 are above, respectively, first and second positions P1 and P2 on the collector (7), and means for holding the web (1) by suction to the underside of the carrier (3, 20) as the carrier and the web move from L1 towards L2 and means for releasing the suction and thereby dropping a length of web onto the collector as a lap extending between positions P1 and P2.

23. Apparatus suitable for use in the process of claim 1 comprising a carrier (3, 20) and a collector (7) located beneath the carrier, means for continuously feeding a web in a first longitudinal direction in contact at a first location L1 with the carrier, means for moving the carrier continuously substantially in the first longitudinal direction from the first location L1 to a second location L1 wherein the first and second locations are positioned above, respectively, first and second positions P1 and P2 on the collector (7), and means for alternately

holding the web 1 by suction against the carrier (3, 20) as the web (1) travels with the carrier (3, 20) from the first location L1 to the second location L2 and releasing the front edge (33) of the web from the carrier lengthwise at half the rate of travel of the carrier and thereby depositing a first lap (8a) on the collector

between the first and second positions P1 and P2 while holding a second lap on the carrier, and

then releasing the length of web which is held on the carrier (3, 20) between the second location L2 and the first location L1 and thereby depositing a second lap (8b) between the second and first positions P2 and P1 overlying the first lap (8a) on the collector (7), and

means for carrying the resultant multi-lapped product on the conveyer 7 away from the carrier (3, 29).

Fig.1.

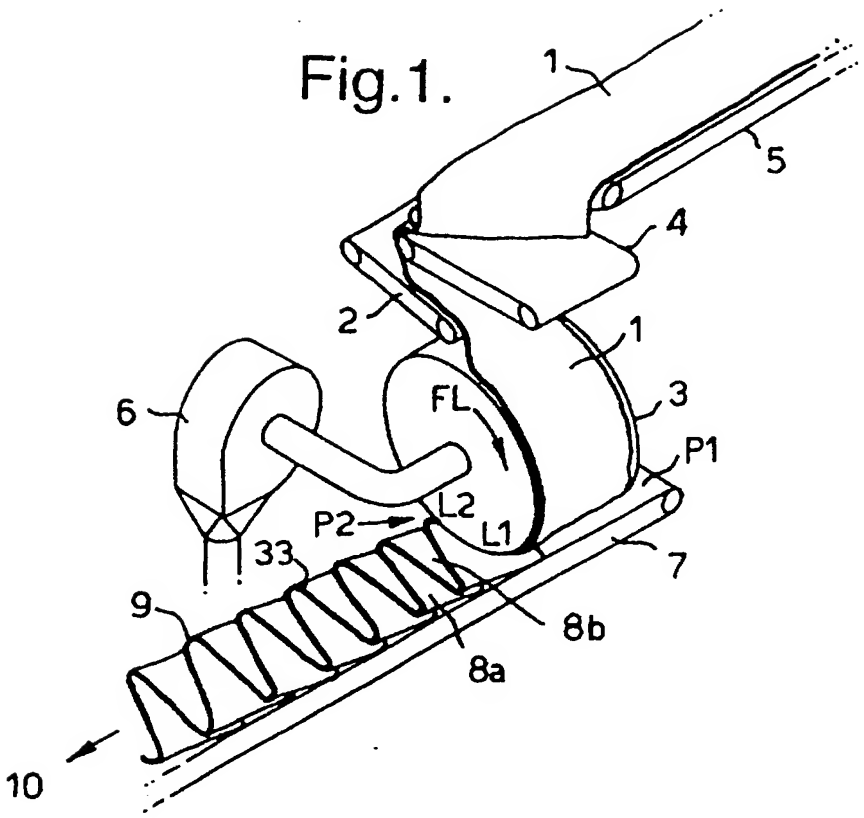
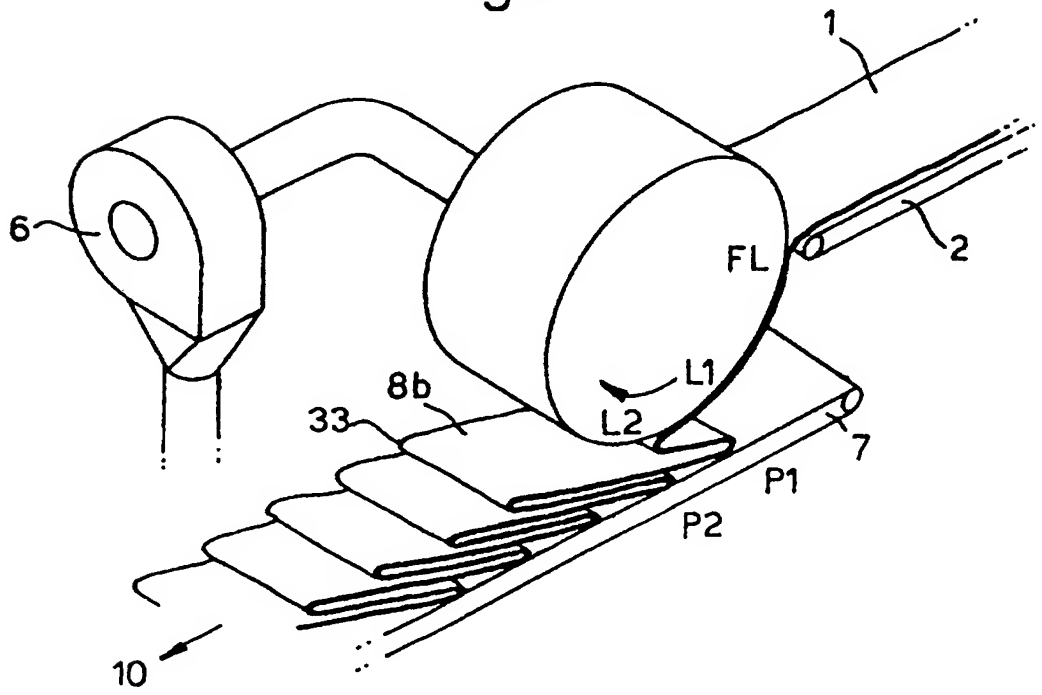


Fig.2.



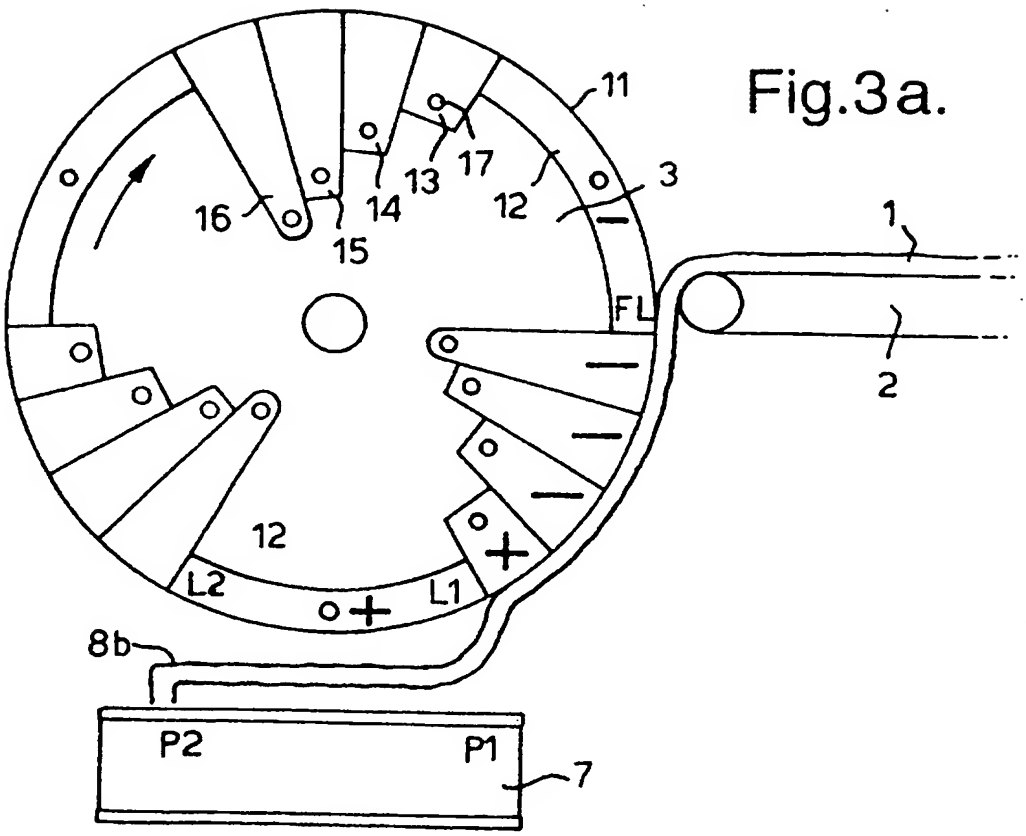


Fig.3a.

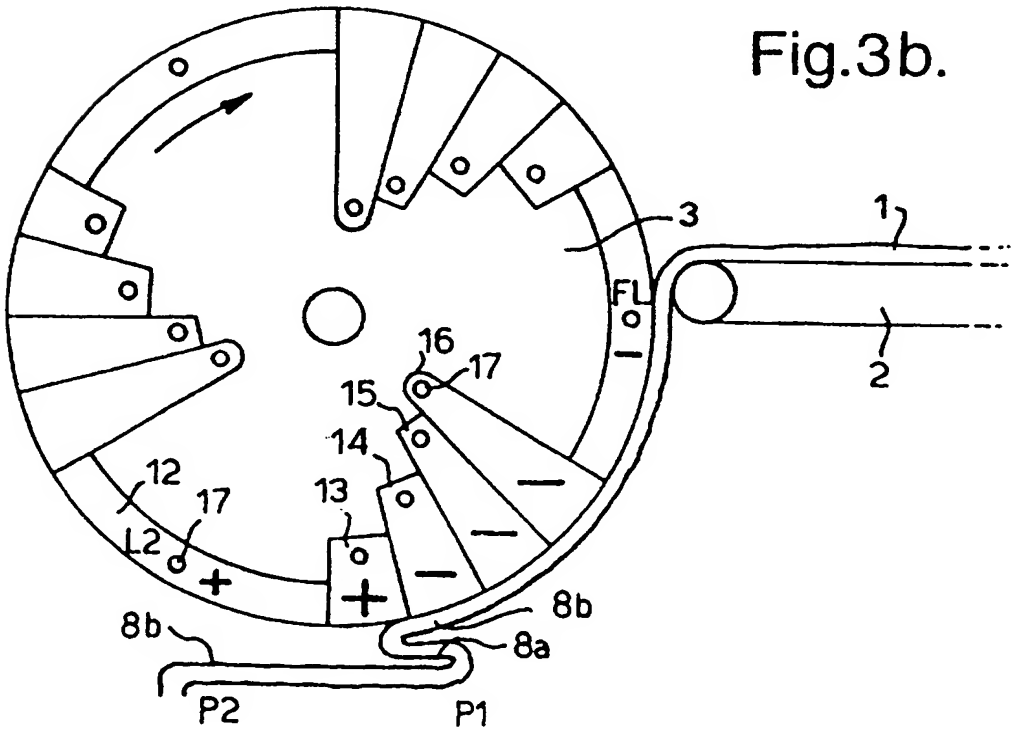


Fig.3b.

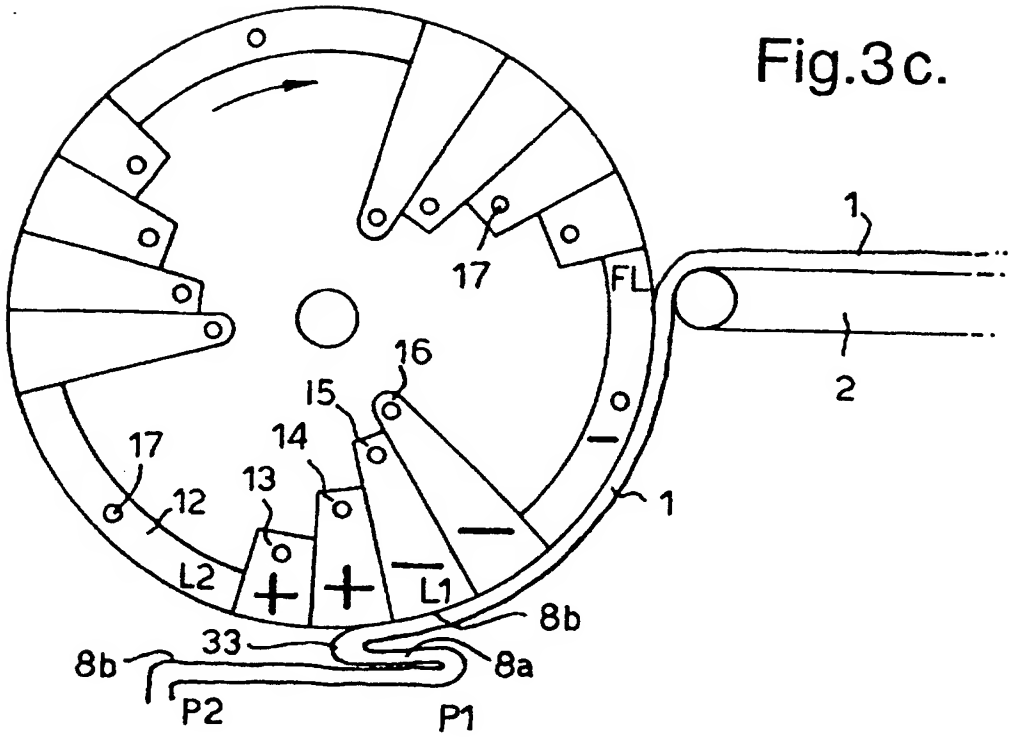


Fig.3c.

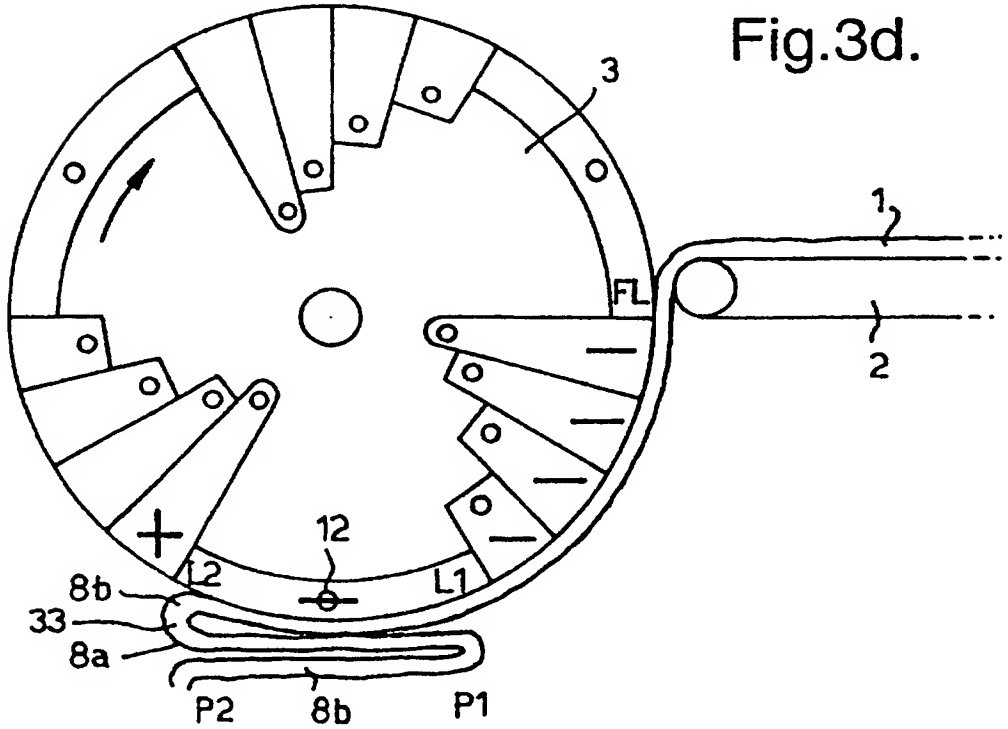


Fig.3d.

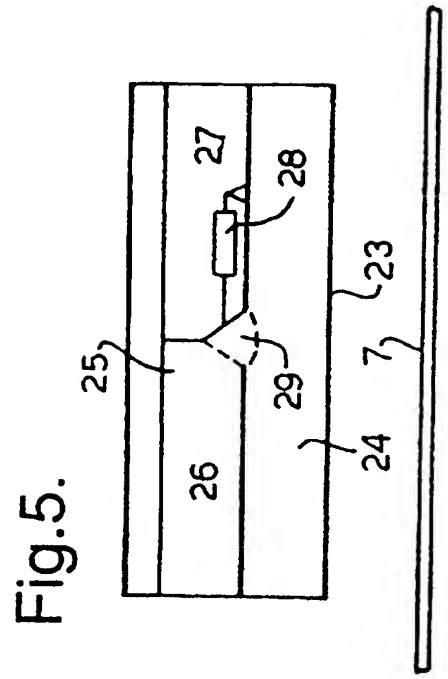


Fig.5.

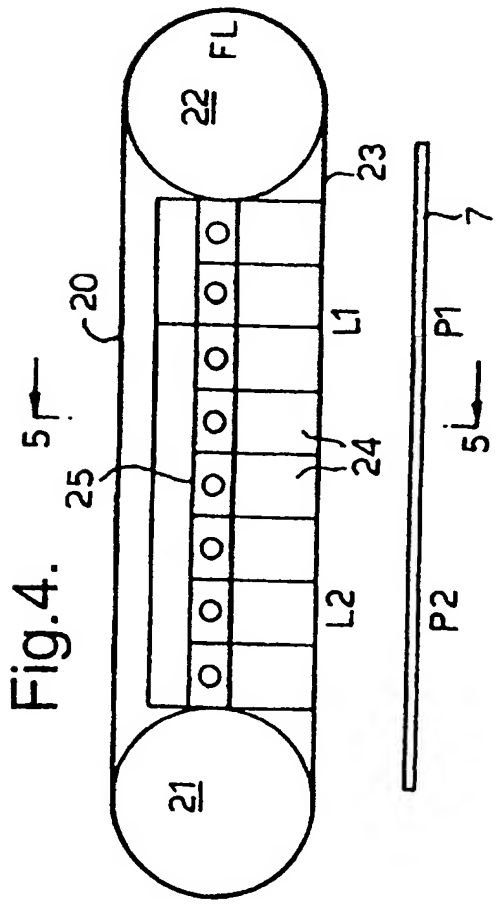


Fig.4.

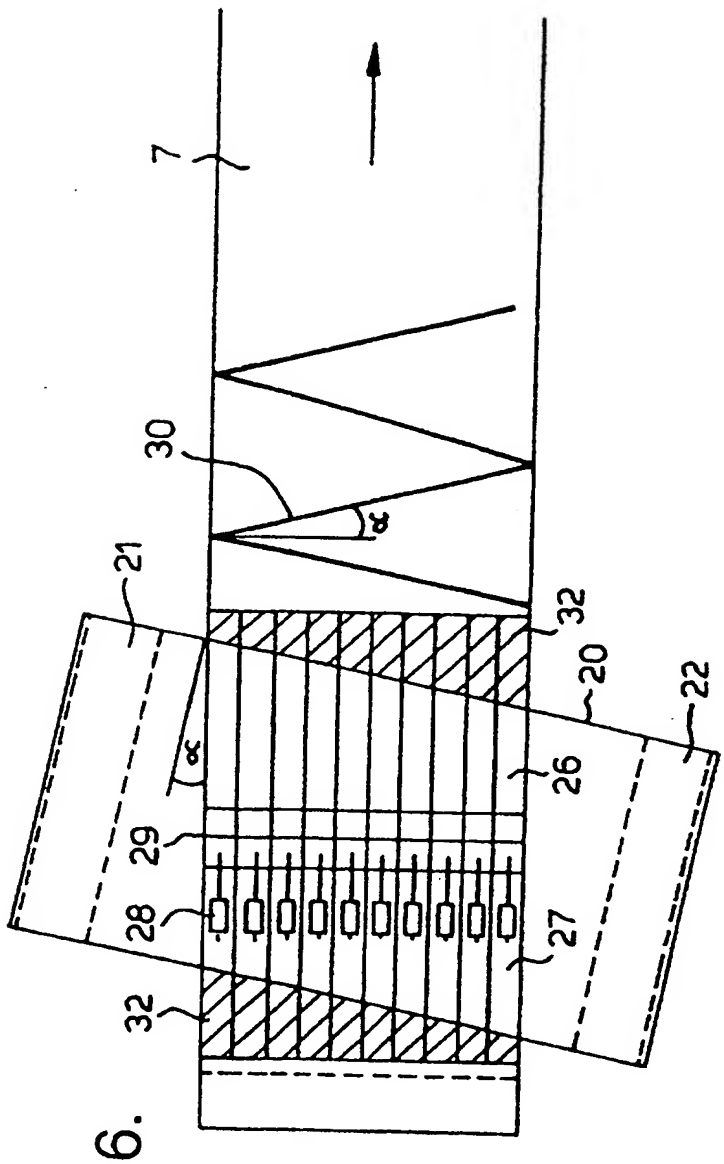


Fig.6.

Fig.7.

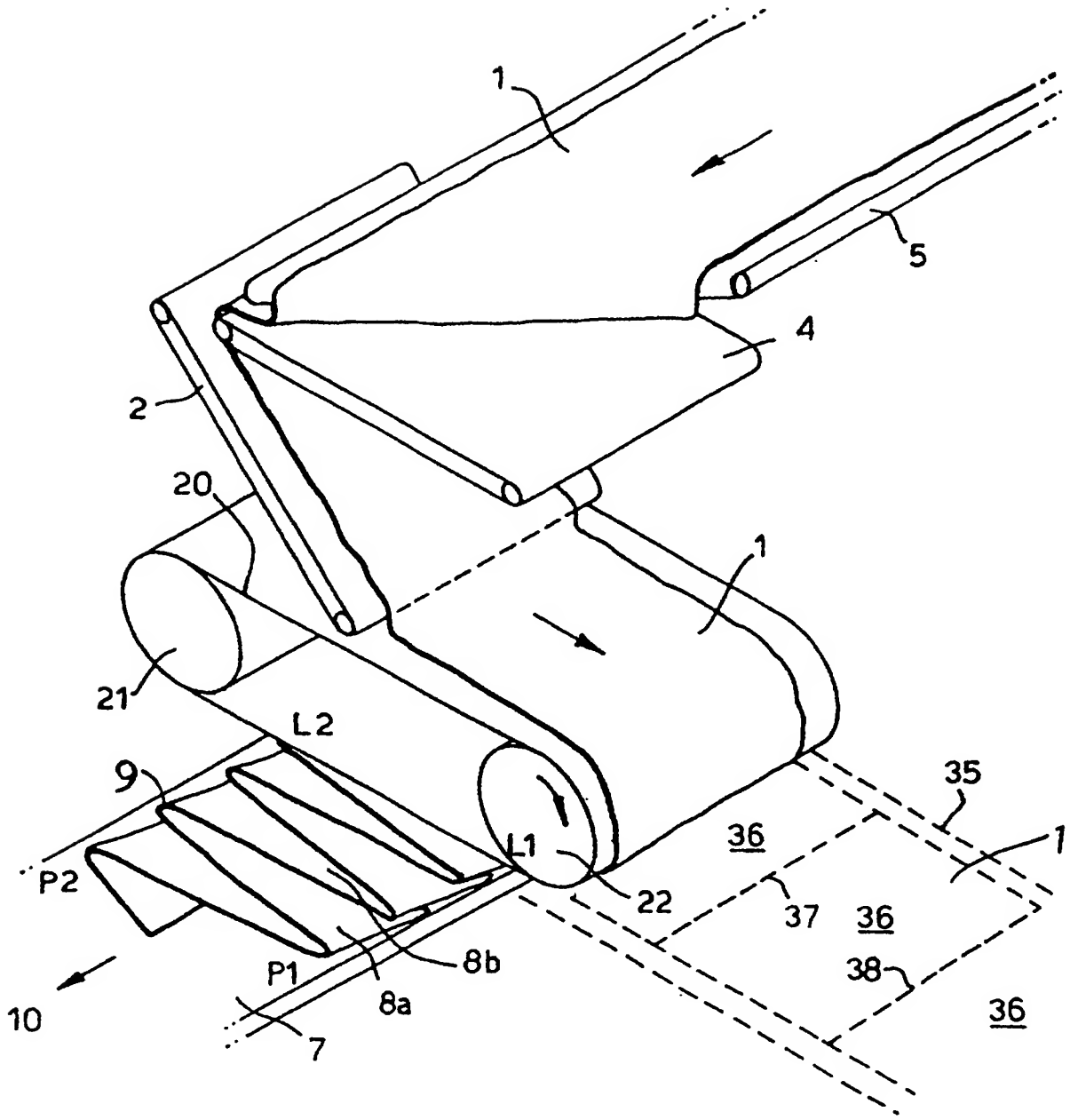


Fig.8.

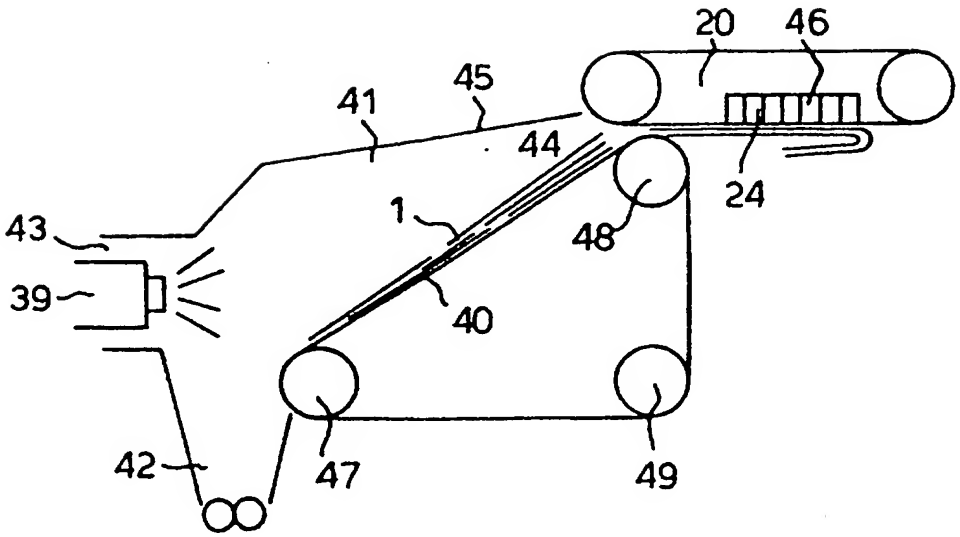

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Fig.9.

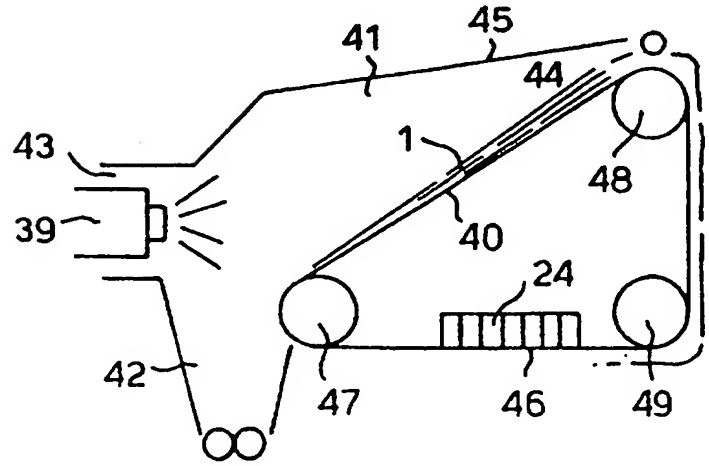
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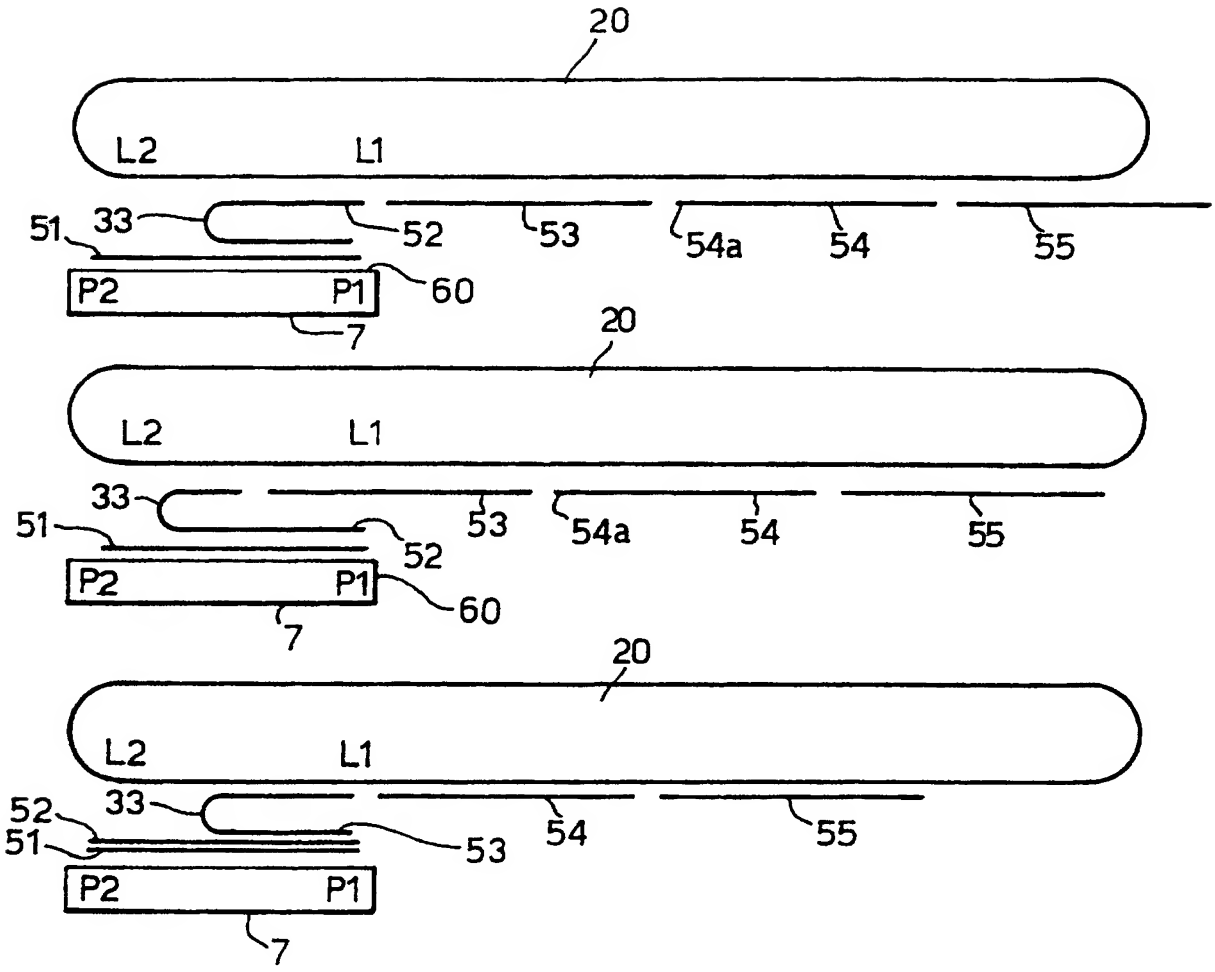
Fig.10.



INTERNATIONAL SEARCH REPORT

Intern ial Application No
PCT/EP 97/00965

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 D04H1/74

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 D04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 280 338 A (ROCKWOOL LAPINUS BV) 31 August 1988 see column 4, paragraph 7 - line 30	1
A	DE 23 55 111 A (TEXTILTECH FORSCH) 26 June 1975 see page 4, line 13 - line 28	1
A	GB 2 268 197 A (MALIMO MASCHINENBAU GMBH) 5 January 1994 see figure 4	1
A	EP 0 343 978 A (SABEE REINHARDT NILS) 29 November 1989 cited in the application see column 14, line 50 - column 16, line 4	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
22 July 1997	11.08.97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	V Beurden-Hopkins, S

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern ial Application No
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